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What's in a face? Making sense of tangible information systems in terms of Peircean semiotics

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ABSTRACT

Within this paper, we utilise a delimited area of philosophy to help make sense of a delimited area of design science as it pertains to a class of contemporary information systems. The philosophy is taken from that of Charles Sanders Peirce; the design science is directed at the construction of visual devices in that area known as visual management. The utilisation of such devices within their wider visual management systems we take to be instances of what we refer to as tangible information systems. Tangible information systems use tangible artefacts, such as whiteboards and magnetic tokens, to accomplish information. We particularly use Peircean semiotics to analyse the use of tangible emoticons articulated upon performance boards within a large-scale manufacturing facility. We infer from our analysis of these informative artefacts that certain integrated aspects of Peircean philosophy offers an alternative way of framing notions of a proper design science, design theory, and design artefact for the discipline of information systems.

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1. Introduction

Within this paper, we utilise a delimited area of philosophy to help make sense of a delimited area of design science as it pertains to a class of contemporary information systems. The philosophy is taken from that of Charles Sanders Peirce (Houser, 1998; Houser & Kloesel, 1992); the design science (Hevner, March, Park, & Ram, 2004) is directed at the construction of visual devices in the area known as visual management (Galsworth, 2005). The utilisation of such devices within their wider visual management systems we take to be instances of what we refer to as tangible information systems (Beynon-Davies & Lederman, 2017). Tangible information systems use tangible artefacts, such as whiteboards and magnetic tokens, to accomplish information. Such systems, as we shall show, are still much evident in and important to contemporary and diverse work settings. They also have many points of similarity with digital information systems.

In previous published research (Beynon-Davies, 2013), we used the case of human emotive facial expression as useful material for grounding a consideration of the philosophy of information (Floridi, 2011). The philosophy of information critically examines the concept of information and its consequences. The background significance of human emotive facial expression clearly underlies the "information" associated with the contemporary artefact of the emoticon. The emoticon is typically taken to be an iconic representation of certain common human facial expressions, many of which are taken to signify emotional state. But, as we shall see, emoticons are used for other than affective purposes in many settings.

For this reason, we take certain inter-linked elements from Peirce's philosophy (Atkin, 2016) to help make better sense of the emoticon as an informative artefact. From his metaphysics, we describe elements of his universal categories which ground his conception of a sign. From his semiotics, we re-examine Peirce's triadic conception of a sign. Signs for Peirce (or more precisely the process of sign-use or semiosis) are central to all human inquiry. From his pragmatism, we examine his contention that the meaning and truth of signs can only be judged in terms of the consequences they make to action. This contention is an essential underpinning of his approach, not only to his semiotics but also to his epistemology.

Within the current paper, we consider a class of contemporary information systems employed in diverse settings such as production and healthcare which employ the articulation of tangible artefacts (such as dry-erase whiteboards and magnetic tokens) for the purposes of coordinating work. These systems are taken primarily

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from the literature on so-called visual management (Galsworth, 2005), which generally seeks to promote the use of so-called visual devices within the visual workplace (Grief, 1991). The use of the term *visual* here is somewhat misleading as the artefacts used within the visual workplace are not just visual they are also haptic/tactile and sometimes kinaesthetic.

The articulation of artefacts such as whiteboards and magnetic tokens for informative purposes within the domain of visual management echoes some of the intentions expressed in the cognate areas of tangible computing (Dourish, 2004), tangible user interfaces (Ishii, 2008), tangible (embodied) interaction (Baskinger & Gross, 2010), pervasive computing (Satyanarayanan, 2001), the internet of things (Atzori, Iera, & Morabito, 2010), and ubiquitous computing (Weiser, 1991). The literature cited (which is representative of a larger body of work) suggests that the design of our interaction with digital computing and communications systems will gradually need to change to accommodate an increased focus on the "tangible". The term "tangible" tends to be used in areas such as tangible interaction to highlight the distinct affordances of interfaces built with physical objects as compared to those built with digital objects. The applications of tangible artefacts within tangible computing applications have been primarily in areas such as learning and play, problem-solving, information visualisation and entertainment. There are a small number of applications which focus on planning but little which highlight the usefulness of the tangible in coordinating group or collaborative work. This appears to mirror a gap in other information disciplines, where interestingly, the manipulation of tangible artefacts used for informative purposes is little discussed in the information systems literature. For such reasons, we refer to physical artefacts used for informative purposes (such as magnetic tokens) as tangible informative artefacts and propose the use of the term tangible information system to denote the systems within which such artefacts are used.

The emoticons used within visual management are a significant example of what we mean by a tangible informative artefact. As we shall see, as a physical artefact an emoticon comprises some iconic representation of a human facial expression impressed typically upon a magnetic token. These physical tokens are used in many different types of tangible information system within settings as diverse as production, healthcare and higher education. However, just like many tangible artefacts, the role of such artefacts as signs for the purposes of "visual management" is relatively unclear. We wish to suggest that understanding tangible artefacts such as emoticons in terms of a Peircean metaphysics, semiotics and pragmatics is critical to developing better design theory for the visual devices central to visual management. We also want to argue that a Peircean perspective offers much to information systems more generally, particularly as it concerns design science (Hevner et al., 2004), design theory (Gregor, 2006) and design artefacts (Gregor & Jones, 2007) relevant to this discipline.

The paper takes the following form. First, we consider the architectonic nature of Peirce's philosophy and demonstrate this by describing the essence and inter-connectedness of some important work from his metaphysics, his pragmatism and his semiotics. This leads us to consider the domain of human emotive facial expression which forms the backdrop for an informative artefact found in many contemporary settings: the emoticon. We consider some of the general uses of emoticons but then focus upon the contemporary ways in which these artefacts are exploited within visual management. Our description of visual management, which follows, is meant to make the case for considering the systems which arise from this approach to operations management as tangible information systems. We ground this consideration in the use of certain visual devices in many settings within one large-scale UK manufacturing organisation, that of the Royal Mint. The author is in the process of conducting the second-phase of a study of tangible information systems with this organisation. The focus of the current paper is upon the visual devices of so-called performance boards. We also narrow our attention to that solely involved with the use of a limited range of physical emoticons upon such boards. Our analysis of these physical tokens, using elements from the philosophy of Peirce, allows us to question not only their basis as signs, but more importantly the purpose they are put to within their overarching work systems. This suggests to us the importance of seeing visual management as an attempt to manage the semiotics of the workplace. We conclude with some potential wider inferences from this insight, namely that Peirce's philosophy offers a fruitful way of re-conceptualising both the idea of information and the associated concept of an information system. Information, we suggest, is an accomplishment only evident within and through the coupling of three sign-action-events. This suggests that an information system must be seen not as a substantive system but as an emergent phenomenon. Our re-conceptualisation of information also suggests the need for different ways of thinking about the nature of "design" (Hevner et al., 2004) in relation to information systems, both tangible and digital.

2. The philosophy of Peirce

Bertrand Russell (1959) saw Charles Sanders Peirce as one of the most important philosophers of the later nineteenth and early twentieth centuries. "Beyond doubt […] he was one of the most original minds of the later nineteenth century, and certainly the greatest American thinker ever" (p. 276). His vast amount of work makes contributions to areas as diverse as mathematics, logic,

physics, computer science, ethics, linguistics, psychology, and the philosophy of science, to name but a few. However, the main problem with the work of Peirce is that elements from his philosophy are taken and explored by various disciplines in a rather piecemeal way and this runs rather counter to Peirce's original intention. This is equally true of many "information" disciplines, such as information systems, information management, information science and computer science.

Peirce's conception of the sign has been much referred to within information systems as a discipline, as well as in cognate disciplines. Mingers and Wilcocks (2014) develop an integrative semiotic framework for information systems based upon a Peircean conception of the sign and use it particularly to promote the theoretical and methodical orientation of critical realism. Stamper, Liu, Hafkamp, and Ades (2000) uses Peirce's semiotics primarily to illustrate the relationship between signs and organisational norms (organisational semiotics). Liu and Li (2015) build upon Stamper's notion of an organisational semiotics and demonstrate its application to business informatics. Liu and Tan (2014) apply the perspective of organisational semiotics to digital visualisation. Price and Shanks (2005) use the distinctions provided by Peirce in his analysis of the sign to clarify essential differences between data and information. Within computer science, a Peircean notion of the sign informs Desouza's (2005) semiotic approach to the design of human-computer interaction. In the cognate area of information science, Huang and Chuang (2009) use Peirce's taxonomy of signs to analyse the phenomena of social tagging, while Friedman and Thellefsen (2011) use the same taxonomy to classify knowledge for bibliometric purposes.

Peirce's work is also frequently cited within information systems in relation to founding the philosophy of pragmatism. Some of the key principles of pragmatism are that human concepts are defined by their consequences, truth is embodied in practical outcome and learning is controlled inquiry, in which rational thought is interspersed with action (Bacon, 2012). Baskerville and Myers (2004) see action research as fundamentally a paradigm for information systems investigation based in pragmatism. Goldkuhl (2006) sees pragmatism as the essential underpinnings of design science research within information systems. Ågerfalk (2010) describes more broadly the importance of pragmatism as offering a unique philosophical orientation for information systems as a discipline.

However, within this literature, which treats Peirce's semiotics or his pragmatism somewhat as reference discipline for information systems, information science or information management (Keen, 1980), little attempt is made to explore his philosophy beyond its surface elements. For instance, in terms of his doctrine of signs, most authors tend to restrict their account to the familiar triad of elements (see below) and use it primarily in opposition to the dyadic nature of the sign employed within Saussurian linguistics (Raber & Budd, 2003). Likewise, those authors who see relevance in pragmatism tend to utilise a much broader notion of pragmatism than Peirce himself would probably be happy with.

Within this section, we want to refocus on Peirce's concept of the sign but argue that other aspects of his philosophy help illuminate an important and neglected aspect of this thinking within the information disciplines – namely, the nature of a sign as a necessary accomplishment through semiosis. This notion of the sign as dynamic process rather than static structure we believe is a potentially useful foundation for establishing some important principles for the design of informative artefacts, ranging from visual devices to electronic records.

Peirce referred to his philosophy as architectonic. By this, he meant that he saw each element of his philosophy as being inherently inter-related. Thus, for instance, his meta-physics forms an essential ground upon which he builds his theory of signs and this theory of signs in turn is seen to be a necessary ground for building his conceptions of logic and its application (Atkin, 2016). Pierce has also been portrayed as a "scientific" philosopher in the sense that he was very much interested in the practical effect of philosophy. This is evident in the ways in which his pragmatism, the idea that any conceptions should be judged in terms of their practical bearing, pervades many aspects of his philosophy.

We do not have space within this paper to do justice to an entire architectonic view of Peirce's philosophy. While acknowledging the limitations of our approach we take the familiar route of focusing upon Peirce's conception of a sign. However, we try to show more clearly how his semiotics is built from his metaphysics and in turn how this conception of semiotics interacts with his pragmatism. In doing this, we attempt to show that signs as central elements within the Peircean architectonic offer a much more sophisticated accounting of some important concepts to the information systems discipline (such as that of information and of an information system) than is portrayed in extant literature.

Metaphysics is that branch of philosophy that deals with the first principles of things. Pierce developed the foundation for his metaphysics upon three universal categories which he called firstness, secondness, and thirdness. Firstness corresponds to undifferentiated qualitative experience or sensation. "The First is that whose being is simply in itself, not referring to anything nor lying behind anything" (Houser & Kloesel, 1992, p. 248). Secondness involves the relation of a first to a second. "The Second is that which is what it is by force of something to which it is second" (Houser & Kloesel, 1992, p. 248). Secondness corresponds to the association between phenomena. For instance, the ability of some

actor to relate one thing to another or to differentiate one thing from another relies upon its ability to perceive similarities and differences between phenomena. Finally, thirdness involves the relation of a second to a third. Thirdness corresponds to mediated relations involving at least three things. "The Third is that which is what it is owing to things between which it mediates and which it brings into relation to each other" (Houser & Kloesel, 1992, p. 248). If the commonality between two things is itself regarded as a thing, then we have a case of thirdness. Hence, the ability of some actor to classify or categorise things and provide a token to denote such categorisation relies upon thirdness.

Firstness, secondness, and thirdness, as pillars of his metaphysics, pervade Peirce's conception of sensation, perception, and cognition, and through this his notion of a sign. Consider a simple example of this. Humans can sense through their sight organ light in the wavelength range 620–750 nano-metres. This is firstness (sensation). Such sensation can be used to distinguish this form of light from another form of light in a different range of the visible spectrum, perhaps 490–450 nano-metres. This is secondness (perception). Finally, both forms of light may be classified as colours and tokens used to denote one perceivable colour from another, such as red and green. This is thirdness (cognition).

Peirce preferred to denote his theory or doctrine of signs in the singular as semeiotic, rather than in the plural as semiotics. Just like logic was for Peirce the science of the necessary conditions for the attainment of truth, semeiotic is that science concerned with the general conditions of signs being signs. Hence, central to his doctrine of signs is his conception of the sign itself, for which he provided many different definitions throughout his life. Three of these are cited below:

> A sign has, as such, three references: 1st, it is a sign to some thought which interprets it; 2nd, it is a sign for some object to which in that thought it is equivalent; 3rd, it is a sign, in some respect or quality. (Houser & Kloesel, 1992, p. 38)

> A Sign or Representamen, is a First which stands in such genuine triadic relation to a Second, called its Object, as to be capable of determining a Third, called its Interpretant, to assume the same triadic relation to its object in which it stands itself to the same Object. (Houser, 1998, pp. 272–273)

> I define a Sign as anything which is so determined by something else, called its Object, and so determines an effect upon a person, which effect I call its Interpretant, that the latter is thereby immediately determined by the former. (Houser, 1998, p. 478)

The terms he uses for the component elements of the sign clearly differ in these three definitions. However, the essential elements themselves remain consistent throughout almost 30 years of exposition. A sign is clearly triadic and as we have seen the triad relates to the fundamental elements of his metaphysics. Peirce proposed that a sign is a threefold relation, consisting of the representamen, the object and the interpretant. The representamen is the signifier, sign-vehicle or representation. The object is the signified or referent; that which is represented. The interpretant is the concept or meaning of the symbol formed through some process of interpretation.

The traditional relational representation of the component elements of the Peircean sign (see Figure 1(a)) tends to suggest that the sign is a separable triad. Better visualisations of the Peircean sign (see Figure 1(b) and (c)) illustrate the way in which the sign only exists within the triad or through the accomplishment of the triad. In other words, the sign is not in any one component element in isolation. Nor is it in all three together as a "structure". Instead, the sign emerges in the mutual coupling of all three component elements within the process or accomplishment of semiosis. This means that a sign is not static but dynamic and is both shaped by its user and shapes the user. "…men and words reciprocally educate each other; each increase of a man's information involves and is involved by, a corresponding increase of a word's information" (Houser & Kloesel, 1992, p. 54). Indeed, for Peirce the human self is a continuous process of sign-action or sign-events. "When we think then, we ourselves, as we are at that moment, appear as a sign" (Houser & Kloesel, 1992, p. 38).

Since the interpretant of a sign is also a sign and this interpretant is a sign to a further interpretant, and

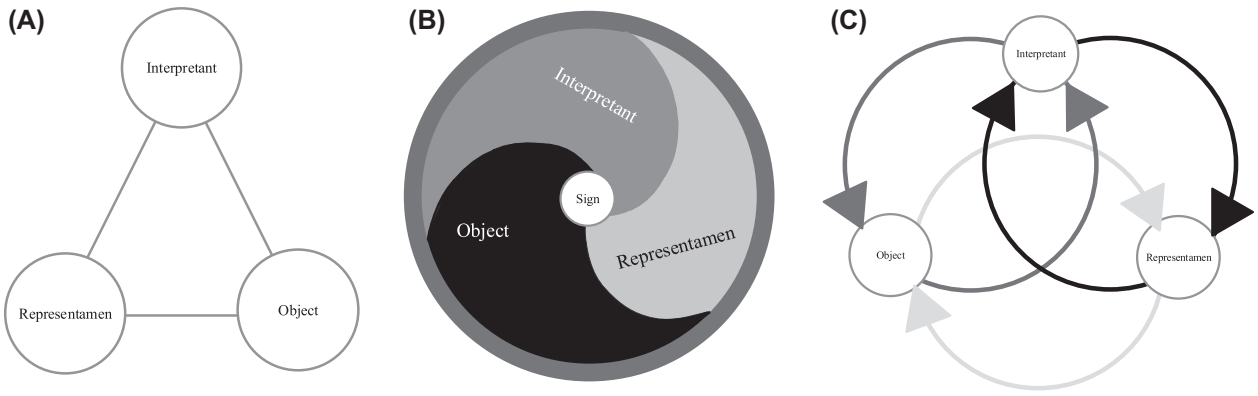

Figure 1. The triadic nature of a sign.

so on, then Pierce establishes semiosis as a potentially infinite process. Consider a deliberately simple example, but which has a bearing on our central case, and which we shall consider at a later point in the paper. Assume that we have a small magnetic whiteboard. Upon this whiteboard, we can place one round magnetic token. This token may be either coloured green or red. As a Peircean sign we might unpack this example in the following manner. The representamen correspond to the sensed features of the physical artefact – the magnetic token. This might comprise the shape of the token, its' position on the whiteboard, or most importantly the colour of the token. The object in this case refers to what the token of either colour stands for – in this case some plant or machinery within a production unit of the Royal Mint. The interpretant refers to what a green or red token is interpreted as meaning (thought to mean) by one or more actors within this setting. In this case, a red token might be taken to mean by production workers that a plant has failed and is hence inoperable, while a green token might be thought of by production workers as indicating that the plant referred to is working and hence operable. Hence, to provide meaning to the tokens we use other signs (red, production worker, plant etc.) which in turn rely on a background of further significance.

To break the infinite regress possible in his notion of infinite semiosis (Atkin, 2016) Peirce, in his later work, introduced some subtle distinctions between immediate and dynamic objects and immediate, dynamic and final interpretants (Nöth, 1990). Objects as perceived, as cognised in the sign, are immediate objects. Hence, in our example the immediate object might be taken to be some general notion of the machinery or plant within a production unit. In contrast, the dynamic object is the "real" or identifiable object within the production unit – the actual piece of plant which exists independently of its perception. Similarly, the immediate interpretant is the meaning of the sign that actors would be expected to understand, while the dynamic interpretant is the effect of such meaning on an interpreter. The final interpretant is the eventual effect on the interpreter after the process of semiosis is complete. Therefore, the presence of a red token upon the whiteboard as an immediate interpretant would mean for interpreters that some indicated plant has failed. The final interpretant in this case would probably be that workers, as interpreters of this sign, would avoid using a certain piece of plant.

In his later work, Peirce related the triadic elements of signs to his universal categories in a number of ways. One of the most critical, for our purposes, is the relationship of the representamen to its object. If the relationship is one of firstness then the sign is an icon. An icon is a sign that has a likeness or semblance with its object – it shares some perceptible quality or qualities with its object. "I call a sign which stands for something merely because it resembles it, an Icon" (Houser & Kloesel, 1992, p. 226). If the relation is one of secondness then the sign is an index. An index denotes its object by virtue of connection between the representamen and its object. "An Index is a sign which refers to the Object that it denotes by virtue of being really affected by that Object" (Houser, 1998, p. 291). However, this connection is irrespective of any interpretation or thought. If the relation is one of thirdness then the interpretamen is a symbol. Symbols are arbitrary signs or signs that rely upon convention. "A Symbol is a sign which refers to the Object that it denotes by virtue of a law, usually an association of general ideas" (Houser, 1998, p. 292). The meaning of the symbol as sign thus relies on some habitual interpretation, some conventional way of thinking by an actor or group of actors.

The crucial point is that in the case of symbols, Peirce's semiotics is not only proposed as an account of language use; it is proposed as an account of thought or cognition – because all thought is in signs and all signs are in thought. "The only thought … which can be possibly cognized is thought in signs. But thought which cannot be cognized does not exist. All thought, therefore, must necessarily be in signs" (Houser & Kloesel, 1992, p. 24). This suggests that signs are not things or structures but events or actions. Thus, the colour red, as a sign, relies upon "actions" or processes of sensation, perception and cognition. Indeed, evolutionary biologists have begun to argue that the explosion of the development of colour upon our planet relied upon the mutual development of the eye as a sense organ amongst organisms. Amongst certain mammals, for instance, the development of the ability of this sense organ to discern light in the wavelength range 620–750 nano-metres mutually developed with the capacity of plants to signal the "ripeness" of their fruits by reflecting light in this range.

But this notion of the sign as dynamic also suggests that we can only judge a sign in terms of the consequences arising from the accomplishment of the sign-event, which will typically comprise further actions. For instance, consider our example of a coloured, magnetic token again in this light. Typically, the token would be denoted as a sign – as something that refers to some other thing in some external reality. But, according to Peirce, the sign is not in the thing itself (the token) or the thing it is meant to refer to (a piece of production machinery); nor is it in the conception or thought of the thing (the current status of the plant). A sign, such as this, is an activity in which a sign-event is accomplished by a particular actor in thought (Hoopes, 1991). But all sign-events are teleological events, they have purposes or consequences. All sign-events are related to the expectations, conventions or habits of the actor accomplishing the sign-event. For instance, a production worker sees a red magnetic token on a whiteboard as a sign of the failure of some plant because he knows or expects that the placement of such a token upon a whiteboard has

been undertaken by some other actor with the intended purpose of preventing potentially wasteful action being taken in relation to such plant, such as trying to operate an inoperable machine.

So, for Peirce there is always an inherent linkage between signs, inquiry, meaning and truth. Peirce is oft-quoted in relation to William James' claim that he was founding father of the philosophy of pragmatism (Atkin, 2016). He first published this approach to inquiry, meaning and truth in the 1870s – particularly in his paper, "How to make our ideas clear" (Houser & Kloesel, 1992). However, he revised his account several years later specifically in response to what he saw to be a misconceived rendering of his earlier views by the pragmatic philosophers James and Dewey (Gallie, 1952). He renamed his account pragmaticism to emphasise such difference. For Peirce, his pragmaticism was not a system of philosophy but only a method of inquiry, and, as a consequence a way of evaluating sign-use.

The fundamental principle of Peircean pragmatism or pragmaticism is that for any sign to be meaningful it must have practical consequences. "Consider what effects that might conceivably have practical bearings you conceive the objects of your conception to have. Then, your conception of those effects is the whole of your conception of the object" (Houser, 1998, p. 346). In terms of this maxim, Peirce provides an account of meaning and truth. If we do not consider the object of our conception to have any practical bearing, then it does not have any meaning. Hence, for Peirce this pragmatic maxim is a tool for the analysis of meaning. It is designed to help us make our signs, concepts and consequently our cognition as clear and meaningful as possible.

So how do we know whether the transformation of some substance constitutes a sign? For Peirce, we can apply the pragmatic test of whether the making of such difference to the substance, makes a further difference in turn (Bateson, 1972). In other words, we must judge any potential sign in terms of its consequences, whether it has any practical bearing on some situation. For example, if we place a magnetic red token on a whiteboard this only constitutes an action within a wider sign-event. We can only judge the magnetic token as a sign if it communicates something to some other actor and by doing so causes some difference to the cognition of this actor. We might also judge the result of such "communication", in turn, in terms of differences made to the consequent behaviour of that actor, perhaps changes to his or her work activity.

It is clear from this that the meaning of the coloured magnetic token in this situation is bound up with certain beliefs held by actors inter-acting with this artefact. For Peirce, a belief is a habit of action (Bacon, 2012), which implies that to establish the meaning of a belief, we must examine the habits it produces, in turn. Peirce maintains that we continually utilise certain unquestioned beliefs, prejudices or habits because they facilitate current action. However, such beliefs are always open to question and may be revised or relinquished at some point if they are no longer found useful. Inquiry is therefore a continuous process of securing belief (Hookway, 1985). Secure beliefs must rely on a community of inquirers scrutinising certain beliefs and testing them in relation to action. Such scrutiny is initiated by doubt in the certainty of certain beliefs by a community of inquirers. A belief is, therefore, that which one would be prepared to act upon, whereas a doubt is a sense of uneasy dissatisfaction experienced when acting according to a belief which does not result in expected consequences. Therefore, inquiry is a matter of securing beliefs which are free from doubt. Inquiry does not aim at truth per se, but security from doubt.

This seems to suggest that Peirce does not support a notion of true belief, which is incorrect (Gallie, 1952). It is apparent from his formulation of dynamic objects and interpretants discussed earlier that both his pragmatism and semiotics supports the notion of real things whose character is independent of opinions about them. He therefore assumes that a process of inquiry can be devised in which the truth of certain beliefs can be fixed by a community of inquirers. This means that the existence of real things can be established or "fixated" in a continuous and an enacted consensus of beliefs held about them. Reality is thus not determined by a community of inquirers, reality is that to which the community of inquirers is led through inquiry.

3. Human facial emotive expressions and emoticons

Mingers and Wilcocks (2014) have proposed that semiotics broadly provides a useful theoretical foundation for much information systems research. More recently (2017) they have attempted to take this further in suggesting a broad framework for conducting semiotic research within information systems. In summary, their framework involves the following stages: appreciating the research situation in semiotic terms, analysing the research material using concepts from semiotics, assessing the validity of proposed explanations in terms of possible semiotic worlds and bringing about change, if necessary, through semiotic processes. Within the next few sections, we want to demonstrate aspects of this approach in considering a particularly narrow institutional problem, using the lens of a Peircean semiotics.

In terms of appreciating the research situation, in this section we want to consider one particularly interesting example of signs which relate to action in a number of fascinating ways within and between contemporary institutions. We first reconsider our previous account of human emotive facial expressions as signs (Beynon-Davies, 2013). This allows us to appreciate the semiotic

context for considering the informative artefacts of emoticons as signs, particularly in relation to their use within the tangible information systems proposed by the operations practices of visual management.

We can summarise what we have learnt from a substantial amount of research on human emotive facial expression in the following terms. The set of human emotive facial expressions comprise an important sign-system (Darwin, 1998). A facial expression results from one or more movements of the muscles of the face. Facial expressions are a form of nonverbal, embodied communication (Mingers, 2001). They involve signs but do not involve use of the human vocal tract. They are an important means of conveying aspects of intent amongst humans in social interaction. The intent communicated through such expressions typically concern emotive state. Such expressions are typically "about" such emotions as experienced by a person or at least some form of emotional intent that this person wishes to express. Emotions are mental states. They are conscious mental states that have some limited duration. Such mental states are typically involuntary and typically about something in the world that matters to us (Ekman, 2003).

What is interesting about facial expressions is that those involuntary emotional facial expressions controlled by the sub-cortical motor system do not appear arbitrary; they do not rely upon convention, expectation or habit. Up to the mid-twentieth century most anthropologists believed that all facial expressions were entirely learned and should therefore differ among cultures. Pioneering work by Ekman and others (1971) eventually supported Charles Darwin's (1998) original contention that certain emotive facial expressions, such as those for happiness, anger and sadness are inherited and thus universal across human cultures (see Figure 2 for the six universal facial expressions).

However, there is a crucial difference between such involuntary facial expressions and voluntary facial expression. Voluntary facial expression is mediated by culture in the sense that people will utilise contextual cues to decide on the appropriateness of certain voluntary facial expressions. Hence, smiling at a funeral is not normally expected, while frowning at a wedding is typically sanctioned, at least in most Western societies.

Therefore, human emotive facial expressions are particularly interesting because in certain situations they are indices, whereas in other situations they are symbols. Involuntary facial expressions appear to be indices – there is an inherent linkage between an emotive state and a certain facial expression. This linkage appears to be instinctual or inherited. In contrast, voluntary facial expressions are clearly symbols. People can make "false" or artificial smiles in social situations and the production of such facial expressions is learned and relies upon convention, expectation or habit.

Human emotive facial expressions clearly form the background semiotic for an artefact much used in contemporary information systems of various forms – that of the emoticon. Emoticon as a term is supposedly a combination of the words emotion and icon. This places emoticons clearly in the camp of iconic signs. They share certain qualities directly with the facial expressions they signify. This means that in many cases we do not need to think about or interpret the meaning of such signs; it is self-evident from the semblance between the sign and its object … Or is it? We shall argue later that there

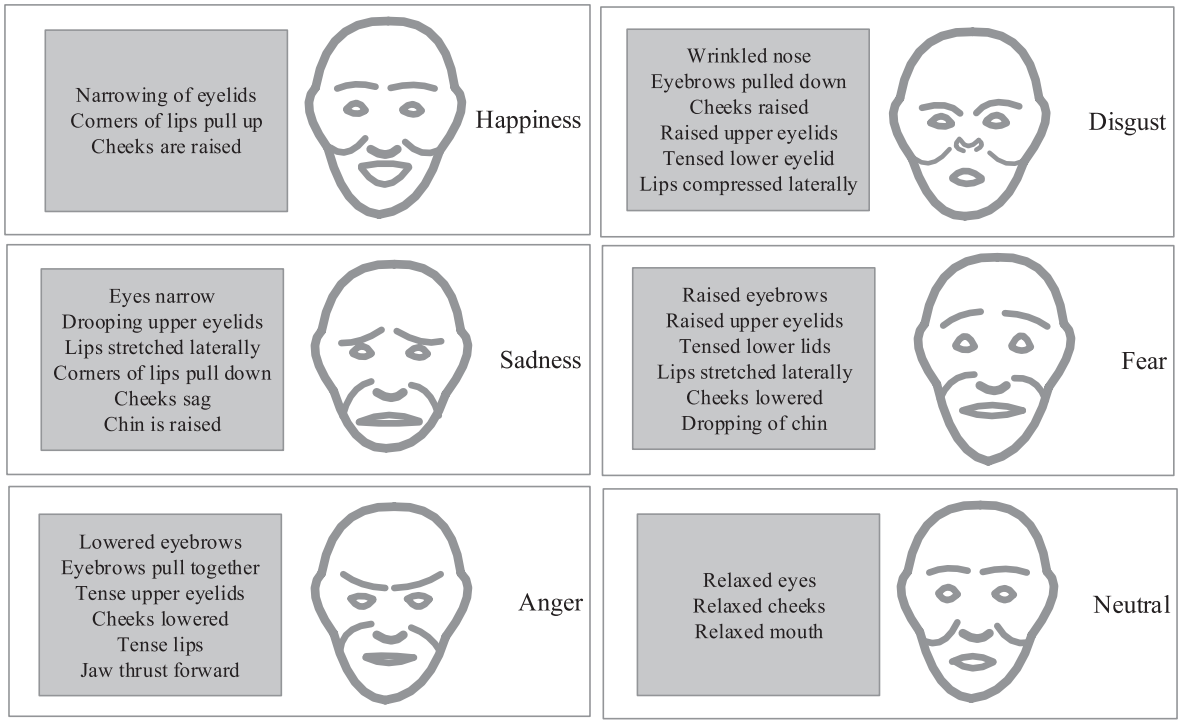

Figure 2. The six "universal" human emotive expressions.

is actually a confusing semiotic associated with the use of these artefacts in many contemporary information systems.

There is evidence of emoticons being used as far back as the nineteenth century. However, it took until the 1970s for these signs to become commonplace. In this period, emoticons were produced as ASCII art by overprinting characters. In the early 1980s, the familiar sequence of characters: -) (smiley face) and :-((sad face) started to be used widely on ARPANET and Usenet, leading to an explosion in forms. With the rise of the mobile phone and its use for texting the emoticon took off in terms of usage, particularly promoting the use of visualisations of certain facial expressions rather than character strings as sign-vehicles. Upon social media, emoticons have become a sub-class of a wider set of picture characters known as emoji.

Beyond the broad classification we have just used it is useful to unpack the emoticon as a sign more directly using the semiotics of Peirce. As a material form, we need to ask, what material differences can we make with an emoticon as a visualisation? Within the simplest of emoticons this is merely the shape of the line denoting the mouth. Hence, to create the simplest of "happy" emoticons we merely need to draw an upward facing mouth, while to create a "sad" face we draw a downward facing mouth. To indicate a "neutral" face we draw the mouth as a straight horizontal line. To draw a fearful emoticon, we turn the line into a circle. To indicate "anger" we use triangles or the shapes "<" and ">" as eyes and draw the mouth as a straight, horizontal line. Finally, to build a visualisation of "disgust" we use a combination of a circle and triangles. What we are doing here is developing an iconic relationship between the differences we make with our graphic and with the physical configuration of the significant changes to the musculature of the face within involuntary human emotive facial expressions. A typical rendering of such emoticons (for the six universal expressions) is given in Figure 3, and includes both a textual version and an emoji version.

This leads to the further question of what differences do emoticons make within the situations in which they are used? In other words, why and how do people use emoticons within computer-mediated communication such as email or texting? From the small amount of research on this (Derks, Bos, & Grumbkow, 2007; Huang, Yen, & Zhang, 2008; Lee, Lee, Bassellier, & Faraj, 2010; Xu, Cheng, & Xu, 2007), the suggestion is that emoticons allow people to increase the information richness (Lee, 1994) of a message by adding some affective (emotional) component or layer to the message. Lee et al. (2010), for instance, finds that emoticons are typically used to reinforce the positive or negative affect of a message. Cyr, Head, Larios, and Pan (2009) find that web-sites which contain human images expressing facial expression are typically seen by their users as being more appealing, "warm" and having "social presence".

For instance, assume we have two simple text messages and we add a single emoticon to each statement:

- Thank you so much for your efforts ☺
- I think you failed me on this occasion ☹

Emoticons in statements such as this are typically taken to be merely iconic representation since they look like the original facial expressions. But, through semiosis, such icons might in turn also be considered

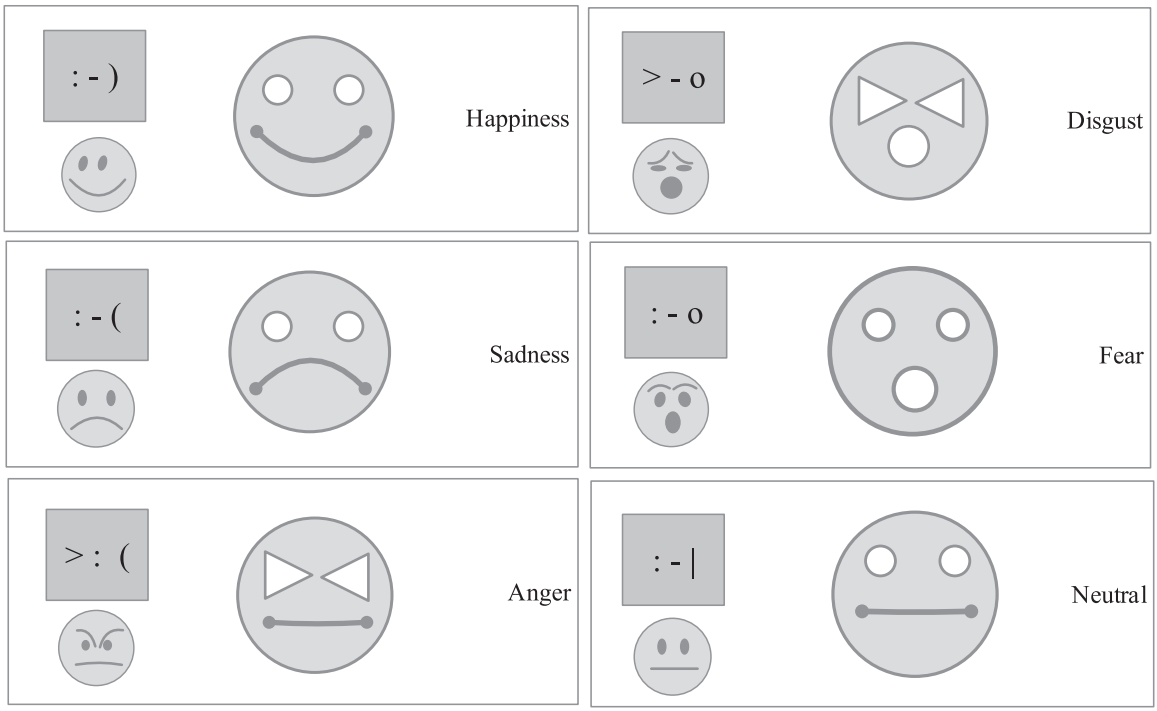

Figure 3. A core set of emoticons (textual and visual).

indices in the sense that there is a causal relationship between the emotion and the expression (at least the universal expression). Thus, in the two messages cited, an interpreter can immediately make sense of emoticons as vehicles to express whether someone is "happy" or "sad" in relation to the context supplied by the message itself. However, emoticons are also used in more complex ways to express an affective sub-text to the message. For instance, adding a particular emoticon to a message can turn it into the opposite of what the statement by itself would be seen conventionally to mean or intend. In other words, an emoticon can be used to build irony into the sign-vehicle of a text or an email.

But emoticons are also used within communication to signify arbitrary or conventional concepts. Consider a modification to our earlier whiteboard example. Upon our whiteboard, we now don't just place red or green magnetic tokens. Instead, we place a green smiley face or a red sad face. We clearly use this to indicate we are happy or sad, but with what? Unlike in the case of the electronic message where the context is relatively clear from the use of other signs (namely, the written statement as a sign-string) the context in the case of the smiley or sad magnetic token is relatively unclear. Within the case of the Royal Mint such icons appear frequently in relation to visual devices. However, the emoticons are not typically used to communicate affect – namely, that an identifiable production worker is "happy" or "sad" about something. Instead, they are frequently used to indicate something concerned with the performance of some plant or machinery. In such cases, the emoticons are not icons or indices; they are being used as symbols. This leads us to inquire more clearly into the semiotics of such signs and determine more precisely what emoticons as signs are used conventionally to do within such work settings.

4. Visual management

To make sense of the use of emoticons in this institution we first need to describe something of the artefacts in which they are used. Visual management is a set of operational practices particularly associated with lean operations in diverse settings such as production, healthcare, software development, etc. (Galsworth, 1997). Visual management is normally implemented in terms of the notion of the visual workplace and the visual workplace is typically instantiated through visual devices. Visual devices are directed at the control of work in the visual workplace; and in such terms visual devices come in various forms.

Galsworth (1997) proposes four main types of visual device linked to a so-called "ladder of control". The idea is that the use of such devices within the workplace helps control the behaviour of workers. Such devices are seen to influence, direct, limit or guarantee such behaviour. Visual indicators influence behaviour in the sense that the device facilitates the sharing of some message, but actors do not need to comply with this message. Visual signals share a message but there is a consequent expectation of some reaction to the message on the part of the actor. Within visual controls the message is built into the physical structure of the device itself. This means that the use of the device physically constrains action. Finally, visual guarantees are physical devices designed to explicitly determine appropriate behaviour unequivocally.

In terms of this typology the emoticons utilised within the Royal Mint are normally used as visual indicators; sometimes as visual signals. However, for our purposes, Galsworth's typology is limited and sometimes introduces confusion. Instead, we find it more useful to unpack such visual devices using the greater sophistication offered through Peircean semiotics. Visual devices are comprised of tangible signs. For instance, unlike the sequence of characters or visualisations familiar within electronic mails, as a component element of a visual device, the emoticon is likely to be made up of a physical token that can be manipulated by the human hand. As such, visual devices as signs form a tangible sign-system. We think of visual management systems and their associated visual devices as tangible information systems. They involve the manipulation of tangible artefacts as signs and such signs seek to communicate between multiple actors. On the basis of such communication, coordinated action between multiple actors is accomplished.

The inspiration for the term tangible information system comes from ideas emerging in the related areas of tangible computing, tangible user interfaces and tangible (embodied) interaction. Tangible computing refers to applications in which tangible objects are interfaced with computers. A tangible user interface (Ishii, 2008) is one in which some physical object(s) is coupled through some computation to digital data. Manipulating the physical object causes changes to the underlying digital data. Correspondingly, the physical state of the object, such as its positioning in relation to other physical objects within some space, reflects the state of the underlying digital data. We see a necessary synergy between some of the themes evident in these attempts at developing the "tangible" in relation to computer systems and an area which has much influenced the design of work systems in areas such as production and healthcare – that of visual management.

Our focus within this section is upon a specific tangible artefact and its position within its wider tangible information system – a visual device built with the express purpose of helping to control performance within production units at the Royal Mint. We also want to focus upon use of one sign (the emoticon) which appears frequently upon such performance boards. We want to highlight the semiotic complexity of such signs within the work systems of this setting. And through a consideration of this case we want to suggest something

of the efficacy of applying the lens of Peircean semiotics to design issues associated with such tangible information systems.

Consider the visualisation in Figure 4. Performance boards such as this are placed in each production unit within the Royal Mint. Such visual devices not only log past performance in terms of some important production metrics, they also indicate what levels are expected over a future time-period.

We shall focus on that limited aspect of these boards associated with the use of emoticons. A large box placed on the left-most extreme of such performance boards is reserved for one large magnetic round emoticon. This box is also typically labelled with the words *plant available*. In terms of articulation, given actors within a production unit can be seen to take two possible actions in relation to this tangible sign. An actor may place a red "sad" face in the box or an actor may place a green "happy" face in the box. In practice, the token is merely switched between the happy face on one side of the magnetic token and the sad face on the other.

In Peirce's terms, there are two inter-dependent signs evident in this example – the emoticon and the box within which it is placed. In other words, the emoticon itself does not refer to any object – the emoticon within the context of the box *labelled plant* available provides the object (an identifiable piece of plant machinery). But what is the interpretant in this case – what thoughts is this sign meant to trigger in the minds of production workers? Clearly, a large emoticon is typically used to signal whether a plant, such as zinc processing or copper processing, is available for operation. A green smiley face is used to signify that the plant is available, while a red sad face is used to signal that the plant is unavailable.

But emoticons are used in other ways upon such performance boards. Consider an element from this visual device blown up in Figure 5. Another set of three boxes are labelled here generically with the words *plant status*, and are used to visually indicate the state of three significant things that affect overall plant operation, namely the number of baskets available, the number of rectifiers available and whether there are any quality issues associated with product. If there are 63 out of a possible 63 baskets available and 40 out of a possible 40 rectifiers available, then a smiley face is used – otherwise a sad face is used. If there are no quality issues, then a smiley face is used; otherwise a sad face is used.

In these two examples, the tangible artefacts are clearly used merely as a binary indicator of the success or failure of some plant or associated parameter. The manipulation or articulation of such an artefact is a symbol in Peircean terms. It relies on production workers knowing the appropriate conventions or building appropriate habits in relation to putting a "happy" or "sad" emoticon upon a designated space within such a visual device.

The key question here is why are emoticons used in these delimited areas of the board, when other signs might be used? In terms of the representamen or form of a sign then just a green and red token might be used or a tick and a cross in the box. In other words, a single difference in colour or perhaps graphic is sufficient to indicate a binary shift of state to the plant or to the parameters described – the interpretant in this case. It is interesting in such cases that these differences rely upon a series of conventions between representamens and interpretants that transport between different action-contexts. Hence, red and green are key differences upon traffic lights used around the world to signal "stop" and "go". Such transportable cultural conventions are sometimes referred to within semiotics more widely, and sometimes confusingly, as codes (Nöth, 1990). The term code was originally adopted from information theory (Shannon, 1949) where it refers to an algorithm for mapping one set of symbols into another. Within semiotics more widely a code is typically taken as referring to a repertoire of

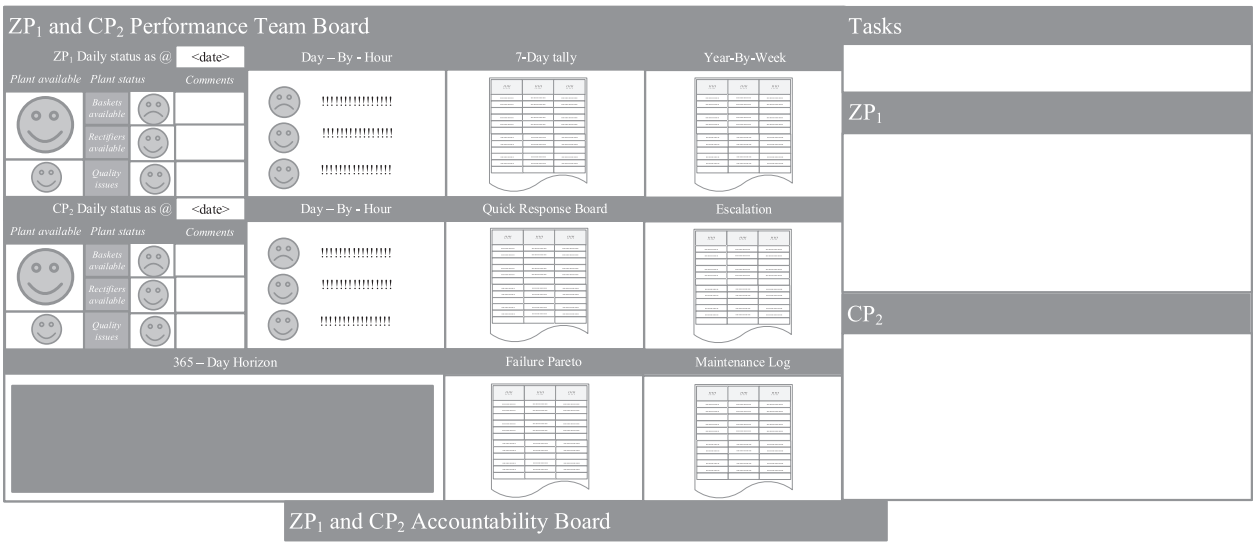

Figure 4. A performance board.

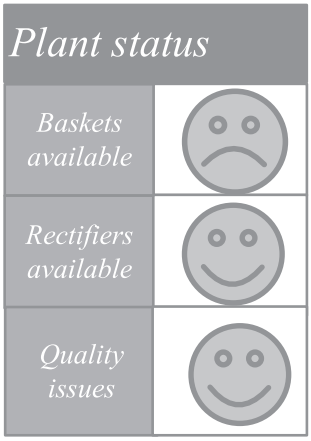

Figure 5. A delimited area of the performance board.

signs or more accurately a sign-system which is adopted across different cultural domains. In such a sense, the universal facial expressions, as we have described them, act as a "code" which is transported from the realm of human, embodied communication into various types of dis-embodied artefact, such as the emoticon.

Another example of certain codes imported into the use of visual devices concern notions of orientation (Kress & Vanleeuwen, 1996). When we view a visual device such as a performance board we inherently adopt certain "codes" in relation to the placement of symbols upon the device. Within European cultures the orientation of the symbols on a whiteboard, for instance, tends to emulate the orientation of symbols on other communication "devices" with which we are familiar, in terms of common conventions, expectations or habits.

Hence, a European will expect to "read" a visual device from top to bottom and from left to right. Such codes of orientation may further influence our expectations as to the meaning of symbols upon a visual device. For instance, if the device is meant to display events of some kind then we might expect symbols relating to "past" events to be placed to the left on the board, while events relating to the future to be placed to the right upon the board. Interestingly, such conventions are not particularly evident in the performance boards at the Mint, where the current situation is placed leftmost while the past plots of performance are placed towards the right.

Likewise, if the symbols relate to certain assessments of worth then we might expect "good" evaluations to be placed towards the top of the board while "poor" evaluations are placed towards the bottom of the board. In relation to the performance boards at the Mint, it is probably no accident that failure and maintenance activities are placed at the bottom of such boards, while the key metrics of performance are placed at the top.

Finally, we also appear to apply certain conventions of centre and periphery to visual devices. Hence, if something is centred in relation to some delimited area of a visual device then the symbol is foregrounded as being "important", at least in relation to symbols placed on the periphery. Hence, it is probably no accident that symbols relating to "quick response" are placed along the central axis of performance boards at the Mint. Actors within production units are expected to react rapidly to the symbols present in this section of the whiteboard.

In relation to the tangible artefacts under focus we might also ask why only two emoticons are used (the smiley and sad face) and to whom do they relate? In other words, it is possible for emoticons to be used on visual devices such as this in a much more personal and iconic way. For instance, they might be used to indicate the "level" of happiness or sadness (in terms of something such as satisfaction) that a certain managerial actor might have with something important to the production unit. Hence, an emoticon may signify being "very satisfied, satisfied, neutral, dissatisfied or very dissatisfied" with some situation by an identifiable actor. In this example, a clear linkage is not only made between an affective state and a certain actor, there is also a greater granularity of affective state signified.

Our experience of visual devices utilised within settings such as the Royal Mint demonstrates that a key problem is that such emoticons are used to signify different things in different contexts. In certain contexts, there is confusion about what the emoticon should mean. In some circumstances (such as in aspects of plant status) they do express (what Searle (1970) would call an expressive) but the expression is something like the level of current satisfaction by the production unit as a whole with some aspect of plant performance. In other circumstances, such as in the case of plant available they merely indicate whether a plant is up and running or not. In pretty much all cases, it is unclear who is attempting to communicate through such signs and particularly what the consequent result of such communication should be.

We need to be clear here that we should be analysing not the sign as a structure but the sign as an action or event. The major usefulness of visual devices as compared to digital computing displays placed within workplaces such as production units relates to both their tangibility and their visibility. The emoticons on such boards are immediately visible to all production workers within the production unit, as are the articulations made to the component elements of such devices. As we have seen, upon such boards, red sad faces frequently appear, signalling that something has gone wrong within the operation of key plant. The practical result of the articulation of such a sign should be that some appropriate action is taken to rectify the situation. The "acid test" of any sign is therefore the action that results from its use. If no difference results from some key difference in articulation upon some device, then no communication occurs and no action can be taken.

It is interesting that on certain other visual boards placed strategically at places within the Royal Mint,

nothing but green smiley faces generally appear. In talking to production workers this is apparently because nothing ever is represented as going wrong with the production process, which these boards are meant to signify. In such situations, the visual devices clearly do not make any difference. No differences are apparent in the tokens placed upon such boards. And, as a result, no difference is made to any action within production units by production workers. So where is the "information" in this case?

5. Managing the semiotics of the workplace

Taking lessons from Peircean semiotics we must be clear within the design of a visual device about three things, for each of the elements of the visual device. These three things relate to the three component elements of the Peircean triad: what is the representatmen, what such a sign-vehicle should refer to and how it should be interpreted. It is tempting to think that design in such terms involves merely the assignment of appropriate types to certain tokens in each case. But this tends to reify the device as merely an "artefact". It supports the notion that signs such as emoticons or the aggregation of such signs within visual devices such as performance boards are merely "structures" or "artefacts" to be designed and manipulated.

The Peircean conception of a sign as an action-event or probably more accurately as a series of inter-linked action-events provides for us a more productive conception of how to do design in relation to a visual element such as an emoticon or a visual device such as a performance board. An emoticon placed upon a performance board is not a structure it is a sign-event; it brings into being an action-space through which actors accomplish "information". The key consequence of this is that the "effectiveness" of the sign and sign-system must and can only be assessed in terms of the relationship of the sign and sign-system to the action it engenders, whether this be another level of semiosis or eventual instrumental action. Hence, the design of signs for use within the workplace must not only consider the material form of the sign and what articulation of this sign is intended to communicate – it must also specify the actions that result from such communication.

For instance, there is a level of concern currently expressed by certain stakeholders within the Royal Mint about the use of visual devices such as the performance boards we have described within plant management. One concrete part of such concern is that expressed about the usefulness of the current semiotic accomplished through the emoticons we have described. As we have seen, the availability of plant is only indicated through these signs currently as being in one of two states – available or not available. In practice, plant managers and engineers want to know when a plant is perhaps running but likely to fail in the future. They also know that certain workers have historically taken certain actions in response to identifiable situations and that such actions have been proven to extend plant availability. What they want from a visual device is an appropriate semiotic established where the significance of certain situations and associated actions is shared amongst production workers.

In design situations with participants from the Royal Mint we have started to explore whether emoticons are really the most appropriate sign for communicating something like plant availability. As hopefully we have established in previous sections, the emoticon as a sign can be quite confusing, partly because of its iconicity. Emoticons as icons for facial expression are probably best restricted to communicating various types of affect, such as expressing some level of satisfaction or dissatisfaction by identifiable actors with designated states of some work situation. In such terms, it is important that the use of any emoticon should be clearly linked to some nominated actor expressing some emotive state. Otherwise the interpretamen of this sign is likely to be unclear or confusing to actors because of the way in which the code of facial expression is transported into this domain.

Generalising from this example we think it possible to treat the design of visual devices within visual management as a "philosophical" enterprise in the Peircean vein. The design of the tangible information systems associated with visual management involves building visual devices appropriate for their designated action-contexts. Visual management for us particularly involves managing what might be referred to as the semiotics of the workplace.

Our work in this area suggests three important things to consider in relation to managing this semiotic. We clearly need to consider the material form of signs, but also how they are articulated upon visual devices. Since most of the signs used upon visual devices are symbols rather than icons or indices we also need to clearly indicate the communicative conventions associated with certain signs and their articulation. In Peircean terms, these are habits that relate material forms to thoughts and consequent actions. Finally, we need to examine the relationship between signs and instrumental action within the workplace. The interpretamen of a symbol is typically used in such settings upon visual devices not to open up further dialogue but as a trigger to one or more resultant actions within the workplace.

It is interesting that within the Royal Mint visual devices, such as the performance boards we have discussed, have been designed by management consultants or by workers themselves with little or no explicit design theory. Taking lessons from a Peircean semiotic we have developed a provisional design theory for visual devices and the tangible information systems within which they take their place. This design theory considers their construction in term of three coupled domains

of sign-action-events (illustrated in Figure 6). The first domain consists of the articulation of structures which act as sign-vehicles. The second domain relates certain acts of articulation with one or more acts of communication. As such this domain is particularly concerned with the relationship between a sign-vehicle and its object. The third domain relates certain acts of communication with some designated act or acts of coordinated activity. As such, this domain relates a sign-vehicle with its final interpretant, which at least in terms of visual devices is directed at the eventual work behaviour to which the sign-vehicle is directed.

Figure 7, for instance, illustrates one sequence of sign-action-events consisting of the articulation of certain emoticons in the Mint, what these signs currently and conventionally are meant to communicate and what work activity is engendered through such sign-use. Through the coupling of such actions, the representamen, interpretant and object of the sign in this case are accomplished or unified.

6. Information systems from a Peircean perspective

As mentioned previously, we take the tangible information systems discussed in this paper to be instances of the wider class of information systems. As such, within the current section we tentatively extrapolate some of the analysis we have made of tangible information systems to the wider class of information systems, which includes those systems reliant on digital computing and communications technology. Applying a Peircean semiotic, we have argued in previous sections for treating information as an accomplishment through sign-use or semiosis. We have also suggested the usefulness of thinking about information as emerging from the coupling of three domains of action that relate to such sign-use. This further suggests the need to reconsider the nature of design science and design theories in relation to information systems as "artefacts".

The idea of a design science, distinct from a natural or a social science, was first proposed in Herbert Simon's Sciences of the artificial (1996). For Simon, such a science is directed at the production of artificial entities (artefacts) rather than something that occurs naturally. Hevner and others (2004) have packaged this perspective more recently as a design science and like Simon believe that such a science should be a "tough, analytic, partly formalizable, partly empirical, teachable doctrine" (Simon, 1996). A number of the information systems academy have proposed a conception of design science which is focused both upon building theories and constructing artefacts for design and action (Gregor, 2006; Gregor & Hevner, 2013; Hevner et al., 2004). According to Gregor and Hevner (2013), design science research within this tradition "involves the construction of a wide range of socio-technical artefacts such as decision support systems, modelling tools, governance strategies, methods for IS evaluation and IS change interventions". But such design artefacts should also be situated within

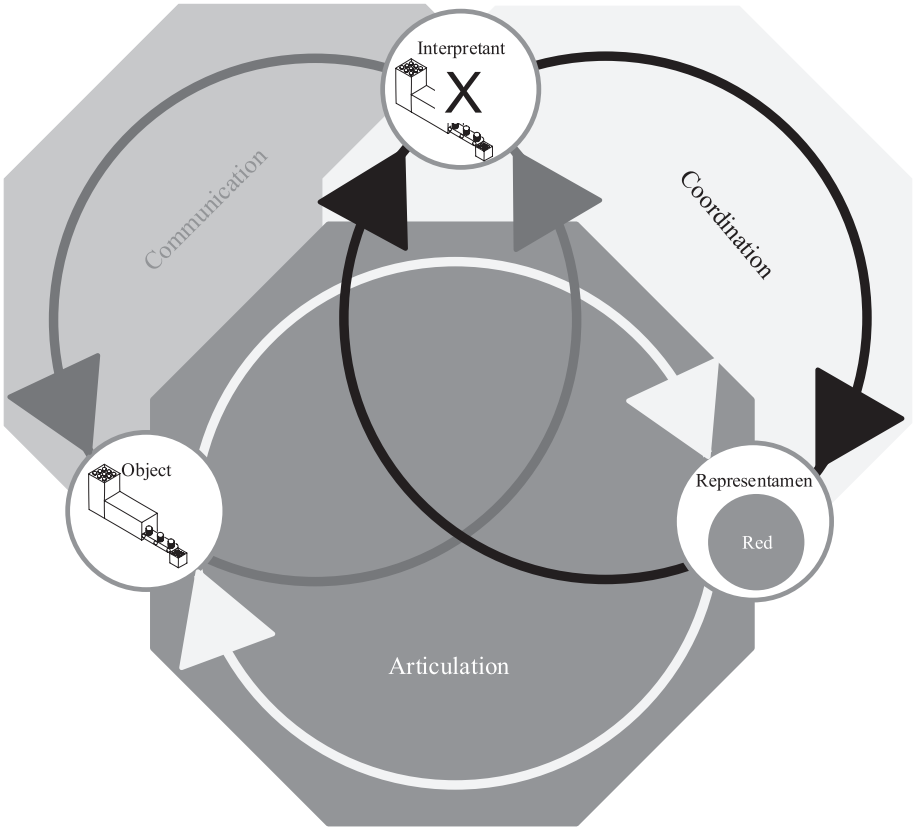

Figure 6. Three domains of sign-action-events.

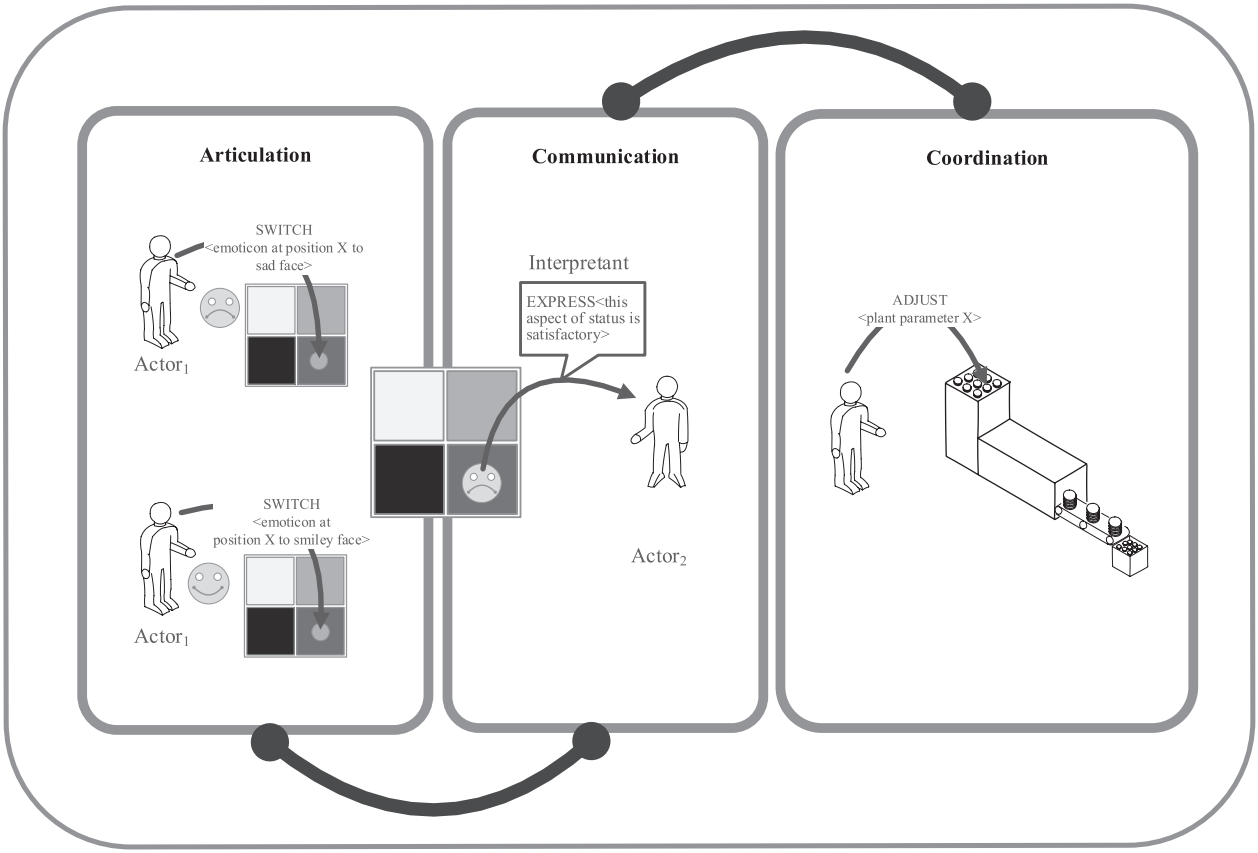

Figure 7. Visualising signs in action.

appropriate design theories. Gregor (2006) suggests that design theory can be seen as one of the five fundamental types of theory relevant to the discipline of Information systems. Design theories focus on how to do something: they provide explicit prescriptions on how to develop design artefacts.

It should be evident from the discussion above that critical to all three inter-related notions of design science, design theory and design artefact is that of the artificial "object" – the artefact – produced as the outcome of any design practice which hopefully also serves to instantiate some design theory (Gregor & Jones, 2007). This debate about the position of the artefact within design science reflects and interacts with a parallel debate about the centrality of the information technology (IT) artefact as locus for the discipline of information systems (Hassan, 2011). This debate has revolved particularly around the positioning of "information technology" in relation to an "information system" as the proper locus for the discipline. Benbasat and Zmud (2003), for instance, have argued for a locus situated in the centrality of the IT artefact. However, Orlikowski and Iacono (2001) argue that there is an unfortunate lack of engagement with the notion of the IT artefact in the Information systems literature. Where such engagement is evident Nevo et al. (2009) maintain that information systems as a discipline takes a special interest in those information technologies that enable communication, collaboration and decision-making. This has led some, such as Alter (2003), to suggest that the proper locus for information systems should be expanded to that of IT-reliant work systems.

Perhaps not surprisingly, in positioning itself in relation to this locus debate, much of extant design science research has tended to frame a notion of a design science concentrated on the IT artefact (Junglas et al., 2011). More recently, Lee, Thomas, and Baskerville (2015) have argued that this is limiting and that the proper artefact to consider in relation to our particular discipline is what they refer to as the information system artefact. For Lee et al., the information system artefact can be unpacked into a separate "technology" artefact, "information" artefact and "social" artefact. This appears to echo some of the developing consensus surrounding the framing of an information system as a socio-technical artefact or more precisely a socio-technical system (Baxter & Sommerville, 2011).

Adapting a socio-technical view means thinking of an information system as a substantive system made up of the inter-leaving of some system of information technology with some system of work. The suggested relevance of viewing information systems through a socio-technical lens has occurred repeatedly within the discipline of Information systems, ever since the landmark paper of Bostrom and Heinen (1977). For instance, the work of Enid Mumford (2006), which has influenced many research studies within IS, explicitly adopts a socio-technical viewpoint. The equally influential body of work by Peter Checkland (1999) implicitly adopts an orienting

distinction between soft (human) systems and hard (technical) systems. More recently, Alter's call (2003) for the IS academy to focus on issues relating to IT-enabled work systems clearly employs a socio-technical lens.

Orlikowski and Iacono (2001) argued some time ago that much research conducted by the information systems academy does not actually study information systems. Instead, it tends to take one of two polar positions. One method of interpretation, characteristic of technological determinism (Benbasat & Zmud, 2003), tends to portray innovations in information technology as a critical force or driver shaping innovations in social systems. Another method of interpretation, characteristic of the social construction of technology (Bijker, 2009), tends to portray information technologies as fundamentally shaped by social forces. More recently, Orlikowski (2005, 2006, 2007) and others (Introna & Hayes, 2011; Leonardi & Barley, 2008, 2010; Orlikowski & Iacono, 2001; Wagner, Newell, & Piccoli, 2010) have tried to resurrect and re-constitute the nature of technology (particularly information technology) within both organisation science and the information disciplines by arguing for the sociomaterial nature of organisational practice. Orlikowski (2007), for instance, argues that

> … materiality is integral to organising … the social and the material are constitutively entangled in everyday life. A position of constitutive entanglement does not privilege either humans or technology (in one-way interactions), nor does it link them through a form of mutual reciprocation. (in two-way interactions)

Defining the sociomaterial as the constitutive entanglement between technology and humans implies that organisational practices are not social, technological or indeed socio-technical practices; they are sociomaterial practices.

We mentioned that Peirce saw his philosophy as architectonic, meaning that he felt that his account of semiotics and pragmatism, amongst other areas, should be treated as a unified whole. His pragmatic maxim was thus for Peirce merely a method for inquiring into the meaning of signs. Meaning (at least as far as symbols is concerned) is a belief in the practical bearings of a particular sign, which is always open to doubt and hence revision. Within the current section, we have inquired into the conception of an information system as a socio-technical system and expressed some doubt as to the practical bearings of such a conception. We have similar levels of doubt in the belief that information systems are best conceived of as sociomaterial systems. We mention just one such doubt here.

The concept of the sociomaterial is an intellectually seductive one for the information systems academy but an extremely difficult conceptualisation to pin down in terms of the pragmatic maxim of Peirce. In other words, it is particularly unclear what difference conceiving of information systems as sociomaterial systems makes to processes of inquiry such as information systems analysis and design. To demonstrate this, consider one conception central to the sociomaterial – that of entanglement. Entanglement, or more accurately quantum entanglement, is a concept borrowed from theoretical physics (Barad, 2007; Vedral, 2010; Von Baeyer, 2003) and refers to that strange phenomenon which occurs when the measurement of the state of something, such as an elementary particle, correlates with an instantaneous change of state to another thing with which the particle originally interacted. As Mutch (2013) argues, from definitions of the sociomaterial, such as the one provided above, it is currently difficult to conceptualise the "state changes" that must constitute entanglement of material and human agency (Leonardi, 2011). In contrast, viewing information systems through the lens of Peircean philosophy seems to us a more productive way in which deficiencies in ways of "weaving the fabric of IT with organisation" (Zammuto, Griffith, Majchrzak, Dougherty, & Faraj, 2007) can be addressed. For instance, in terms of the analysis provided in this paper any notion of entanglement (we prefer the term coupling) must refer to the ways in which the sign as an inter-leaved cycle of action-events is constituted in the continuous accomplishment of organising. The sign is clearly an enacted whole. However, as hopefully we have demonstrated, any sign can and must be analysed in terms of separable "fields" of enactment to be made sense of in practice.

Therefore, our experience of inquiring into tangible information systems in practice raises certain doubts about ways in which information systems are conceptualised not only as socio-technical or sociomaterial "artefacts" but also about ways of doing design science research in relation to the information system artefact. We wish to argue that the conception of an information system as a substantive system is particularly difficult to apply productively within practical situations of design, such as the ones we have considered in relation to visual management. This, we feel, is because a conception of an information system as a socio-technical or indeed as a sociomaterial system fails to adequately account for the emergent nature of information itself as an accomplishment enacted through semiosis.

Consider the very simple example of the articulation of emoticons upon performance boards within the Royal Mint. Where is the information system in this example? The information system is clearly not in the "technology". Indeed, our example (at least as far as the coordination of work through magnetic tokens is concerned) deliberately does not involve any information technology, at least as conventionally conceived. The information system is also not in the work or coordination system nor does it solely lie in the communication system, as we have portrayed it. This leads us to suggest that assigning the concept of an information system to the category of one or more of these substantive systems,

which each contribute to a way of organising, is to commit what Ryle (1949) refers to as a category mistake. A category mistake is an ontological error. It involves instantiating something as belonging to a category or class when this thing belongs to a different category or class. Ryle introduces this idea through anecdotes, such as the following. A visitor on making his first visit to Oxford and seeing the college buildings and the library, asks of his guide, "but where is the university?" The visitor here makes the category mistake of assuming a university is equivalent merely to physical infrastructure rather than to institutional infrastructure. Likewise, Ryle argues, the idea of treating the mind as an object made of an immaterial substance commits a category mistake. For him there is no "ghost in the machine" – the mind cannot be separated from acts of the body, and more precisely, a critical organ of the body, the brain. We believe that within information systems as a discipline there is a marked tendency to commit a similar category mistake, or perhaps two related category mistakes in relation to an information system as a concept.

First, much of the extant literature tends to equate an information system necessarily with the application of digital computing and communications technology. We have attempted to demonstrate within this paper that the concept of an information system must instantiate a different category altogether if it is to satisfactorily explain the efficacy of a large range of non-digitised systems that enable the effective coordination of work in diverse and contemporary settings. This suggests that we need to treat an information system as a meta-concept detached from any technologies, such as the visual devices of visual management systems.

Second, Ryle started an approach to the concept of mind which regards it as an emergent system reliant upon certain physical systems, most importantly the central nervous system. In a similar manner, a close analysis of examples such as the one considered in the current paper suggests that the concept of an information system is better conceived of not as a substantive phenomenon but as an emergent phenomenon. An information system can be observed to emerge from the coupled inter-action of articulation, communication and coordination activities, all working together. The term information system properly stands for certain properties that emerge from what we have referred to in previous work as the continuous enactment of significance (Beynon-Davies, 2011). Such properties emerge from the inter-action between the articulation of material artefacts, the communication of intent and content that such entails and the coordination of the work of multiple actors that results from such articulation and communication.

This re-framing of the information system "artefact" as an emergent phenomenon rather than a substantive system has one important consequence. We take it as a general principle that these three layers of action can be analysed separately but in practice are coupled. The idea of coupling is taken from the work of Dourish (2004), where he defines it as "the degree of coordination of two elements, and how that coordination is maintained". We further propose that this idea of coupling, at least as it applies to tangible information systems, is useful in unpacking the relationships between actions of articulation, communication and coordination. The coupling between the articulation and communication domains refers to the ways in which actors use the manipulation of sign-vehicles with the intention of affording communication between themselves and others. The state of the articulation domain at any one time may serve to communicate collective intentions, which, in turn, affords the coordination of work.

Hence, an information system is best considered a phenomenon that emerges from the coupling of not two domains of system, but three domains of sign-action: an articulation domain, a communication domain and a coordination domain. Phrased in Lee et al.'s (2015) terms an information system is not an aggregation of technology, information and processes, it is an accomplishment achieved through inter-related or coupled action with signs enacted by ensembles of humans, machines and artefacts within such domains. An information system is a system of action with and through signs. This leads us to suggest the need for a design science, as well as design theories and design artefacts which do justice to this action-oriented view (Baskerville, 2008; Baskerville, Lyytinen, Sambamurthy, & Straub, 2011).

7. Conclusion

We have attempted within this paper to focus upon an aspect of Peircean semiotics which is frequently under-emphasised, particularly in literatures which import the triadic nature of the sign into some way of explaining communicative patterns. The sign, for Peirce, is not a structure, it is a process. A sign emerges through the accomplishment of actors within semiosis. A sign is thus an event, or more precisely a coupled triad of action-events. Just like Mingers and Wilcocks (2017), we feel that this way of making sense of signs and their positioning within ways of organising offers much potential for resolving certain difficulties with the enduring problematic of information technology and organisation (Zammuto et al., 2007).

Our intention in this paper has not been to supply a comprehensive account of Peircean philosophy and an analysis of its value to information systems, as a discipline. Instead, it has been to demonstrate how certain integrated aspects of Peircean philosophy suggest an alternative orientation to notions of design theory appropriate to a certain class of information system. In line with Peirce's general orientation that philosophy should be both evaluated by and utilised within practical action,

we have attempted an analysis of visual management through certain inter-linked aspects of his philosophy.

As we have seen, Lee et al. (2015) frames the information system artefact in terms of three related types of artefact which they refer to as the "technology" artefact, "information" artefact and "social" artefact. We suggest a reframing of an information system not as an aggregation of artefacts but as a coupled system of socio-communicative-technical action. This refocuses attention from an interpretive framing of an information system to a pragmatic framing of an information system (Ågerfalk, 2010; Goldkuhl, 2012). For us, an information system must constitute an ensemble of actors taking coordinated, communicative and articulative action (Beynon-Davies, 2010), that includes not only machines such as computers but also artefacts such as data structures.

Our conception of the coupling of socio-communicative-technical action has some synergies both with the frameworks proposed by Dietz (2006) and that of Stamper (2001). Dietz does not appear to build his framework for enterprise ontology directly upon semiotics although his forma/informa/performa distinction seems to have many elements of similarity with our articulation/communication/coordination cycle. Stamper's conception of an organisational semiotics owes much to the work of Charles Morris (1946), who directly uses Peircean semiotics but diverges from it in substantial ways. Within organisational semiotics signs are analysed in terms of four related layers, including empirics, syntactics, semantics and pragmatics. Empirics consider the physical and technical nature of signs whereas pragmatics considers the social constraints and consequences of sign-use. This layered conception of the sign is useful in emphasising the complexity of signs and their use but tends to suggest a structural or relational view of the sign and a consequential phased method for conducting semiotic analyses.

In contrast, we have spent some time explaining how a Peircean conception of the sign demands an action-oriented or process view of the sign. The consequence of this for us is that to operate analysis and design as a form of Peircean inquiry, the researcher or designer must engage with the way in which three domains of sign-action-event are necessarily coupled through semiosis in any way of organising. As we have tried to demonstrate in our process of abduction between case and theorisation, any true semiotic inquiry as far as Peirce is concerned must acknowledge the unified nature of signs as accomplishments achieved through semiosis. Hence, to properly analyse and/or design signs the focus of the researcher or designer must continuously move back and forth between how signs are articulated, what they conventionally are intended to communicate and in what way they achieve coordination.

Within this paper, we have concentrated on the semiotics of emoticons as exemplified in one situated instance of institutional practice. This analysis allows us to clearly delimit what emoticons do and do not do within this workplace. As such, we are able to think through more clearly issues relating to the intent of signs used within visual devices. We would suggest that through this lens we can start developing appropriate design theory in terms of better managing the semiotics of the workplace.

We have focused our critique of the notion of artefact within design science by considering the limitations of viewing tangible information systems as socio-technical systems. However, there are evident problems also with the way in which the idea of the socio-technical (and even the sociomaterial) is typically applied in relation to the association between the articulation of IT artefacts (such as enterprise resource planning systems or patient administration systems) and organisational work, which illustrate the potential wider application of the philosophical orientation to research described here. For instance, a recent paper (Volkoff & Strong, 2013) speculates about the organisation-level affordances of IT usage for collaboration in organisations. This implies that in some way manipulation of an IT artefact has effects within the area of work, such as improving or supporting group collaboration. The theorisation provided in the current paper, based within the philosophy of Peirce, helps better explain how such support is enacted, but not as a straightforward direct linkage (sometimes portrayed as a linkage of causality) between technology and its application to work.

Clearly an IT artefact (such as a hospital patient records system or a hospital email system) affords actors certain actions such as being able to make and view electronic patient records or write and view emails. However, the affordances of the IT artefact apply purely within the domain of the IT artefact itself and involve solely the articulation of data structures as sign-vehicles. The concept of affordance, as originally conceived (Gibson, 1977), cannot explain how articulations performed in relation to the IT artefact are used as cues or triggers to further action by actors in another context or domain – the domain of coordinated work. For instance, it cannot explain how the action of actor A in making a record through an artefact such as a hospital patient administration system triggers a consequent change to the action of actor B who detects that electronic record on the patient administration system, and then performs an action in a completely different place (such as at a hospital bed) and at a different time (such as one working shift later).

Hence, information systems as a discipline needs better ways of accounting for and unpacking this wider conception of its' key locus - that of an information system. Another way of putting this is that we agree with Alter (2003) that in considering the design of information systems for areas such as production, manufacturing and healthcare we should focus upon wider systems rather

than purely digital computing technologies. He suggests a focus upon work systems. We would suggest a focus on ways of organising and how such ways are constituted through Peircean semiotics. Unlike some of the suggestions evident in the literature on the sociomateriality of information systems, we maintain that the relationship between the articulation of some artefact and the communication it enacts is always subject to temporality; as is the relationship between some act of communication and the coordinated activity it enacts. Hence, there is a necessary temporal lag between one actor articulating a magnetic token, another actor interpreting the meaning of such articulation, and yet another actor performing some activity. The lag may be seconds, minutes, hours, days, weeks or potentially even months, depending on the work setting. We have also been interested in those situations in which the sign-action-events are enacted not by a single actor but by multiple actors. The consequences of situated aspects of semiosis therefore must be unravelled not in terms of simple sequences of sign-action-event but in terms of patterns of organising constituted through communities of inquiry.

Within this paper, we have used our way of thinking about the semiotics of the workplace to help unpack why visual management works or does not work as tangible information systems. It is our intention to pursue and evaluate this method for unravelling the emergent nature of information systems in further studies. We are in the early stages of applying and refining this design theory within further engagement with organisations. For instance, as intimated in the paper, we are exploring the design of visual devices within the Royal Mint in areas such as preventing plant failure. This work will hopefully further explore the ways in which signs not only serve to build institutional ontology (about what "things" are seen to exist) but also assumptions about both positive power (rights, permissions, authorisations etc.) and negative power (obligations, duties, responsibilities) associated with such "things" (Beynon-Davies, 2016).

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